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STUDIES OF INFESTATION.

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SEQUOIA NATIONAL PARK.

MARBLE FORK PROJECT.

SEASON OF 1918.

J. M. Miller

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Assistant Forest Entomologist.

Ashland, Oregon,

January 22, 1919.

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D. BREVICOMIS - YELLOW PINE

TREE NO.	JUNE					JULY					AUGUST					SEPTEMBER					OCTOBER				
	5	10	15	20	25	5	10	15	20	25	5	10	15	20	25	5	10	15	20	25	5	10	15	20	25
B2 (UNIT 11)																									
ELEVATION 5600																									
ATTACK																									
EGGS																									
LARVAE																									
PUPAE																									
NEW ADULTS																									
EMERGENCE																									
B93T (UNIT 11)																									
ELEVATION 5700																									
ATTACK																									
EGGS																									
LARVAE																									
PUPAE																									
NEW ADULTS																									
EMERGENCE																									
B8 (UNIT 11)																									
ELEVATION 5700																									
ATTACK																									
EGGS																									
LARVAE																									
PUPAE																									
NEW ADULTS																									
EMERGENCE																									
B92T (UNIT 11)																									
ELEVATION 5100																									
ATTACK																									
EGGS																									
LARVAE																									
PUPAE																									
NEW ADULTS																									
EMERGENCE																									
B23 (UNIT 11)																									
ELEVATION 5300																									
ATTACK																									
EGGS																									
LARVAE																									
PUPAE																									
NEW ADULTS																									
EMERGENCE																									
B20 (UNIT 11)																									
ELEVATION 5200																									
ATTACK																									
EGGS																									
LARVAE																									
PUPAE																									
NEW ADULTS																									
EMERGENCE																									
B18 (UNIT 12)																									
ELEVATION 6000																									
ATTACK																									
EGGS																									
LARVAE																									
PUPAE																									
NEW ADULTS																									
EMERGENCE																									
B31 (UNIT 11)																									
ELEVATION 5200																									
ATTACK																									
EGGS																									
LARVAE																									
PUPAE																									
NEW ADULTS																									
EMERGENCE																									
B36 (UNIT 11)																									
ELEVATION 5300																									
ATTACK																									
EGGS																									
LARVAE																									
PUPAE																									
NEW ADULTS																									
EMERGENCE																									
B30 (UNIT 11)																									
ELEVATION 5100																									
ATTACK																									
EGGS																									
LARVAE																									
PUPAE																									
NEW ADULTS																									
EMERGENCE																									
B36 (UNIT 11)																									
ELEVATION 5300																									
ATTACK																									
EGGS																									
LARVAE																									
PUPAE																									
NEW ADULTS																									
EMERGENCE																									

First Seasonal Generation

Second Seasonal Generation

D.VALENS-YELLOW PINE



STUDIES OF INFESTATION, MARBLE FORK PROJECT,  
SEQUOIA NATIONAL PARK, SEASON OF 1918.

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Location and Scope of Field Work.

Following the control in the spring of 1918, Mr. Wagner was stationed at Colony Mill and kept a set of life history records and other data from May 20th to October 10th. The trees under observation were located in the Marble Fork and Cactus Creek watersheds. This work involved a continual cruise of the two units, and an effort was made to mark the 1918 trees as soon as possible after attack. The records secured apply to the following subjects:

- I. Character of infestation in infested trees at time of control work.
- II. Life history records of broods in overwintered trees (1917 second generation)
- III. Life history records of broods in trees attacked during season of 1918.
- IV. Trap tree experiments to determine attraction of beetles to felled or standing trees.

I.

CHARACTER OF INFESTATION AT TIME OF CONTROL WORK.

The following analysis has been made of trees treated on Units 11 and 12:

Yellow Pine.

	No. trees	Volume
Trees infested by <i>D. brevicornis</i> only	11	44,040
" " " <i>D. brevicornis</i> and <i>D. monticolae</i>	1	480
Total -----	12	44,520

No doubtful trees on Unit 11 recorded.

In four of these trees, composing a volume of 32,200 board feet, it was estimated that from 25% to 75% of the broods had emerged. Within the area covered by the control, seven other trees with a volume of 19,560 board feet were marked, but left untreated. In these trees 90% or more of the broods had emerged. This shows that out of a total ~~at~~ yellow pine volume of 64,080 board feet, marked during the period from May 15th to June 10th, more than 80% had been partially or entirely abandoned by the beetles. The actual proportion of the beetles which had emerged can of course only be estimated. This estimate is included in the following comparison:

	No. trees	Volume.
Total infestation marked, May 15th to June 10th	19	64,080
Emergence recorded in	11	52,360
Percentage of volume in which emergence recorded		81.7%
Estimated proportion of beetles which had emerged		50%

The infestation on Units 11 and 12 outside of the area covered by control work was not marked until late in the summer when all overwintered broods had emerged.

Sugar Pine.

*D. monticolae* was the only primary insect recorded in this host.

Trees are as follows:



	No. trees	Volume .
1. Positive, infested at base	40	163,630
2. Doubtful, green at base	5	19,180
Total----	45	182,810

Of the positive trees, seven were abandoned in the top, while strong broods were found near the base. The remaining 133 trees were infested from the base to the top by *D. monticolae*.

	No. trees	Volume .
Containing full broods of <i>D. monticolae</i> --	33	125,010
Infested at base, but abandoned at top---	7	38,620
	40	163,630

The following table shows the infested and abandoned lengths of the seven partially abandoned trees:

Tree No.	D.B.H.	Height	Volume	Infested length at base	Abandoned length at top
A 12	32	90	1450	70	20
A 13	58	190	8140	60	120
A 14	40	150	3490	70	80
A 44	62	160	9300	20	140
A 45	58	160	8140	30	130
A 53	56	170	8000	50	120

In the following table the doubtful trees are compared in the same way as those found on Unit 10:

Tree No.	D.B.H.	Height	Volume	Uninfested length at base	Length infested by <i>D. monticolae</i> at top.
A 41	38	130	2780	15 feet	110
A 42	54	150	6530	10	130
A 48	46	160	4920	50	100
A 51	38	160	3130	30	120
A 74	32	130	1920	20	100
A 57 *	40	150	3130	150	No insects found on bole Foliage was infested by a needleminer causing feeding appearance.

\* Not classed with treated trees.



## II.

### LIFE HISTORY RECORDS OF BROODS IN OVERWINTERED TREES.

The control work interfered with consecutive brood records and very little complete or satisfactory data was gathered. An analysis of the brood records in the treated and untreated trees during the period, May 20th to June 5th, gives the following:

#### D.brevicornis in Yellow Pine.

Stage of Insect.	No. trees in which recorded.
------------------	------------------------------

Attack	
Parent Adult	1
Egg	1
Small to half grown larvae	
Half grown to full grown larvae	10
Pupae	14
New Adults	13
Emergence	10
Entirely abandoned	1

Consecutive records of emergence were secured from one tree only which was located on Unit 10.

Tree No. A 1; Unit 10; Elevation 4000 feet.

April 5, 1918. Full grown larvae, pupae, new adults.  
 April 23, 1918 New adults emerging, about 75% abandoned.

This tree, however, was about 1000 feet lower than any of the trees considered on Unit 11.

On Unit 10 it was noticed that considerable emergence had already occurred in some of the trees at the time control work started early in April. It is hard to explain this unless a considerable amount of the emergence occurred in the fall before the overwintering period set in. This apparently



was what occurred in many of the trees on Unit 11. Records which will be obtained in the spring of 1919 from trees in which attack was recorded in summer and fall of 1918 will throw considerable light on this condition.

D. monticolae in Sugar Pine.

An analysis of the brood records in the treated sugar pine for the period, May 20th to June 10th, gives the following:

Stage of Insect	No. trees in which recorded.
Attack	
Parent Adults	4
Eggs	1
Small to half grown larvae	3
Half grown to full grown larvae	43
Pupae	40
New Adults	16
Emergence	5

The untreated sugar pine trees which were marked during this period were left because of their inaccessibility and not because of an abandoned condition. It is evident, however, that some emergence had occurred before June 10th, but this constituted only a very small percentage of the beetles.

One exceptional case which cannot be explained occurred in an overwintered sugar pine, Tree No. A 7. This tree was felled on May 15th, but owing to a shift in the camps a crew did not return to treat it. At the date of felling, the tree contained parent adults and small to half grown larvae, and was infested for its entire length. The tree was next examined on August 26th when the following note was made,

"Broods of new adults still under bark; no evidence that any have emerged; all healthy and active; some of them seem to be feeding on dead inner bark tissue which is in a semi-moist condition. A considerable proportion of the pupae seem to have been killed in pupae cells."



Trap trees which had been attacked in June in the same locality were entirely abandoned at this date. Tree No. A7 was felled with the top lying downhill, and it is suggested that this may possibly have some bearing on the retarded emergence.

### III.

#### LIFE HISTORY RECORDS OF BROODS IN TREES ATTACKED DURING SEASON OF 1918.

Records of broods in trees of the 1918 first generation are of a much more satisfactory character. A number of trees were located soon after attack and the development of the broods followed through until the trees were abandoned. The records were also started on a series of trees of the second generation and when these are completed next spring we will have a much better understanding of life histories in this region.

#### D. brevicornis in Yellow Pine.

Records were secured from five trees in which development was completed during the season and are therefore classed as first generation trees. Records were also secured from five trees in which broods had not advanced beyond the larval stage by the 10th of October. These will probably be overwintering trees. Development is shown in chart on page 16.

The first attack was found on June 17th when the beetles were just starting their attack on tree No. B-2. Emergence was completed by August 18th or in sixty-three days. Careful observations indicate that no standing trees were attacked on the area prior to this date. In the other first generation trees which were found the broods developed in approximately



the same period.

Attacks in trees of the second generation appeared to begin about the last of July and continued into September. It is a curious point that even in the trees which were attacked as early as July 28th, the broods did not develop beyond the full grown larval stage by the 10th of October.

The records indicate that we have here one complete seasonal generation and a partial second. Owing to the absence of more detailed data for the spring period it is not considered that a reliable comparison can be made with the life history data at Ashland. It is evident, however, that no great amount of difference will be found between them. Brood records at Ashland were collected at an average elevation of 3500 feet, Lat.  $42^{\circ} 15'$  North, Lat.  $122^{\circ} 45'$  West. Records on the Sequoia were taken at an average elevation of 5500 feet, Lat.  $36^{\circ} 30'$  N., Lat  $118^{\circ} 30'$  W. It is hoped that with the records for the spring of 1919 we will have sufficient data for a reliable comparison between the two localities under the Hopkin law.

#### D. monticolae in Sugar Pine.

Records were secured on eleven trees which are shown in the chart on page 17. One unexpected feature of these records is that they show the development of a pronounced first seasonal generation in more than half of the trees. One of the earliest attacks was located on June 15th; emergence was completed by August 20th, or in 67 days. Considerable variation is noted, however, in the period of development in individual trees. Seven of the record trees are considered to belong to the first seasonal generation and four to the second generation. This point cannot be determined for all trees, however, until additional records are taken in the



spring of 1919. Apparently, however, there is one complete seasonal generation and a partial second.

#### Ips confusus in Yellow Pine.

Very good records were secured for this species in two yellow pines and one sugar pine which had been felled as trap trees. The broods developed fairly uniformly in all trees. Attacks started about the 10th of June and emergence was completed by July 25th, or in 46 days. (See chart, page 15 ). No attacks were found which would provide suitable records for the second seasonal generation.

#### D. valens in Yellow Pine.

Records were secured in one tree only, indicating one annual generation. They are not, however, complete or satisfactory. (See chart, page 16 ).

### IV.

#### TRAP TREE RECORDS AND EXPERIMENTS TO DETERMINE ATTRACTION OF BEETLES TO FELLED OR STANDING TREES .

The trap trees which were available for this study can be classed as follows:

1. Uninfested bases of doubtful trees cut during control work.
2. Green trees cut especially for trap trees.
3. Standing green trees on which an effort was made to induce an attack of flying beetles.

#### 1. Doubtful trees as Traps.

Practically all of the doubtful trees which were felled during the



control work on Unit 10 and left with an uninfested portion of the trunk, were found to have attracted strong broods of the beetles when they were re-examined in August and September. This applies to both yellow pine and sugar pine. On Unit 11 no doubtful yellow pines were felled. The six doubtful sugar pines which were felled attracted broods of beetles and four of them were treated during the summer. In addition to these one green sugar pine was felled by the road crew. Their records for the trap trees which were treated are as follows:

: Tree No.	: Date of felling:	: Uninfested length	: Date of attack by <i>D. monticolae</i> :	: Date of treatment:	: Condition of brood:
: A 48 B96T	: May 21	: 50 feet	: June 7	: July 28	: larvae, pupae:
: A51 B95T	: May 22	: 30 "	: June 14	: July 25	: larvae, pupae, new adults:
: A57 B94T	: May 25	: entire length:	: June 12	: July 25	: larvae, pupae, new adults:
: A74 B97T	: May 31	: 20 feet	: June ?	: July 27	: larvae, pupae:
: B11T	: May	: entire length:	: June ?	: July 26	: larvae, pupae:

## 2. Green Trees cut for Trap Trees.

Three yellow pines were felled near Colony Mill to insure brood records of the first seasonal generation of *D. brevicornis*. These were suppressed trees, selected so as not to injure the forest and two of them were located with a view of obtaining some data on the flight of the beetles. The records of these trees are shown in the following table:



: Tree No. :	Date of felling:	Date of attack by D.brevicomis :	Date of attack by Ips confusus :	Date of treatment :	Condition of brood.
: A54 (B92T) :	: May 23 :	: June 27- eggs and larvae :	: June 6 :	: July 24 :	: D.brevicomis; larvae; pupae; new adults; Ips confusus abandoned.
: A55 (B93T) :	: May 23 :	: June 27- eggs and larvae :	: June 6 :	: July 23 :	: D.brevicomis; larvae; pupae; new adults; Ips confusus abandoned.
: 4T :	: Sept. 6 :	: No attacks found when tree was last examined, October 10th.			

In the two trees which were attacked *D. brevicornis* occurred only on the sides and under part of the fallen trunk. None were found on the top which was mostly occupied by *Ips*.

It is interesting to note that the tree felled in September was not attacked at all, although plenty of time had elapsed for an attack to occur by October 10th when records were discontinued. Trap trees which were studied on the Ashland area attracted broods of beetles up until June 10th when the last tree was felled. It is possible, however, that trees cut late in the summer during the attacks of the second generation may not prove successful as traps. On the whole the *D. monticolae* broods which are attracted to sugar pines appear to be heavier and stronger than the broods of *D. brevicornis* which are attracted to yellow pines. The use of sugar pine as <sup>a</sup>trap in the control of the mountain pine beetle apparently offers good chances for success.

Flight Data. Trees B92T and B93T were located at a point which so far as could be determined was about one mile distant from the nearest source of infestation. The lower timber line at Colony Mill extends out along the summit of a narrow ridge, forming a distinct peninsula in the type, and these trees were located toward the extreme southern end of this peninsula. This



is illustrated by the map on page 18 . The location of the nearest trees from which beetles might have come is also shown. It cannot be claimed absolutely that there was no infestation nearer than the trees indicated, as some beetles may have been concealed in broken limbs etc. However, a very close search of the small belt of timber under consideration failed to disclose any. It is evident that no infestation existed anywhere in the vicinity of the trap trees which would account for the quantity of beetles attracted to them.

### 3. Artificial Attraction to Standing Green Trees.

Mr. Craighead during his visit suggested the caging of beetles with standing green trees, so as to force their attack into the lower part of the tree, thus creating an attraction which might draw in flying beetles.

Mr. Wagner tried this with *D. brevicornis* on six yellow pine trees as follows:

A piece of bark about two feet square, infested with pupae and new adults of *D. brevicornis*, was nailed to the side of a tree and covered with small muslin cage. The following notes show the results in the first experiment which is representative of all the others:

**Experiment I. Yellow Pine. D.B.H., 32 inches. Height, 125 feet.**

July 25, 1918. Yellow pine bark, 24 x 24 inches, infested with pupae and young adults of western pine beetles, nailed to tree; covered with muslin cage.

August 10, 1918 Opened cage; found two dead *brevicornis* adults; no attack; experiment continued.



August 24, 1918. Opened cage; found 16 dead adults in cage and 15 fresh attacks on enclosed surface of tree; nearly all attacking beetles have been drowned out by resistance of tree. No attacks found outside of cage. Case closed.

Of the remaining five trees three were attacked by the caged beetles, while in two trees no attack at all occurred. The attacked trees all successfully resisted the beetles. No attack by flying beetles was observed in any of the trees. The experiment indicates that during this period of the year at least, artificial attraction cannot be induced by this method.

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# LIFE HISTORY RECORDS.

Ips Confusus in Yellow Pine  
and Sugar Pine.

—\*— indicates date of record.

Tree No.		—June—						—July—						—August—					
		5	10	15	20	25		5	10	15	20	25		5	10	15	20	25	6
B 92 T	attack	*—	—	*—	—	*													
(Unit 11)	eggs			—*—															
Yellow Pine	larvae				—*—														
Elevation	pupae					—*—													
5200	new adults					—*—		*	—	—	—	*							
	emergence							*	—	—	—	*	—	*					
B 93 T	attack	—	—	*	—	*													
(Unit 11)	eggs			—*—															
Yellow Pine	larvae			—*—	*	—													
Elevation	pupae					—*—		*	—	—	*	—	*						
5200	new adults					—*—		*	—	—	*	—	*						
	emergence							*	—	—	*	—	*	—	*				
B 94 T	attack	—	—	*	—	*													
(Unit 11)	eggs	—	—	*	—	*													
Sugar Pine	larvae			—*—															
Elevation	pupae					—*—		*	—	—	*	—	*						
5600	new adults					—*—		*	—	—	*	—	*						
	emergence							*	—	—	*	—	*	—	*				







Trap Tree Experiment - Colony Mill.

Scale - 4 inches = 1 mile.

Showing location of two yellow pine trap trees felled May 24, 1918, and possible sources of *D. brevicornis* beetles which infested them.

Yellow area represents distribution of yellow pine timber.

A and number represents trees from which *D. brevicornis* beetles emerged in the spring of 1918.

